



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.04.2005 Bulletin 2005/15

(51) Int Cl.7: **H01C 17/00**

(21) Application number: **04078539.6**

(22) Date of filing: **25.02.2000**

(84) Designated Contracting States:
DE FR GB

(30) Priority: **21.12.1999 US 471622**

(62) Document number(s) of the earlier application(s) in
accordance with Art. 76 EPC:
00911996.7 / 1 240 650

(71) Applicant: **Vishay Dale Electronics, Inc.**
Columbus, NE 68602 (US)

(72) Inventors:
• **Smejkal, Joel J., Vishay Dale Electronics, Inc.**
Columbus, Nebraska 68602 (US)

• **Hendricks, Steve E., Vishaj Dale Electronics, Inc.**
Columbus, Nebraska 68602 (US)

(74) Representative: **Thomson, Paul Anthony**
Potts, Kerr & Co.
15, Hamilton Square
Birkenhead Merseyside CH41 6BR (GB)

Remarks:

This application was filed on 27 - 12 - 2004 as a
divisional application to the application mentioned
under INID code 62.

(54) **Overlay surface mount resistor and method for making same**

(57) A method for making a plurality of surface mount resistors comprising: taking a ribbon comprising an elongated resistive strip (28), an elongated first metallic strip (32) and an elongated second metallic strip (30), the resistive strip having a longitudinal axis, an upper edge, a lower edge, a front flat surface, a rear flat surface and a central portion (12) between the upper and lower edges, the resistive strip being made of a resistive material and the first and second metallic strips being made of a metallic material that is different from the resistive material; joining the elongated first and second metallic strips to the front flat surface of the resistive strip adjacent the upper and lower edges thereof respectively, with the first and second metallic strips being spaced apart from one another across the central portion (12) of the resistive strip, the joining being done by a cladding process without the use of braising alloys or adhesive; making a plurality of cuts (50) in a direction transverse to the longitudinal axis of the resistive strip so that the plurality of cuts extend through the resistive strip and the first and second strips to create a plurality of resistor bodies (51), each of the resistor bodies comprising a resistance member having front and back surfaces, first and second conductive metal terminal ends attached to the front surface of the resistance member and spaced apart from one another, and an exposed portion of the front surface of the resistance member between first and second terminal ends; connecting the plurality of resistor bodies together while making the plu-

rality of cuts so as to hold the plurality of resistor bodies together; and severing the resistor bodies from one another to create the plurality of surface mount resistors.

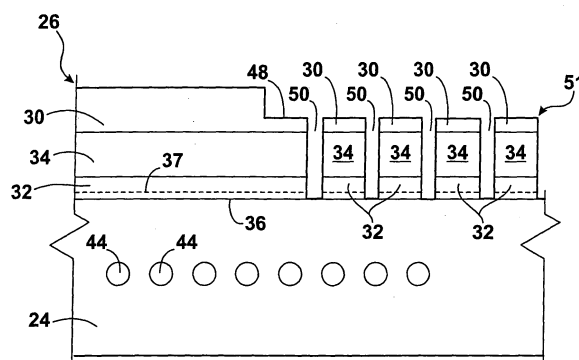


Fig. 4

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an overlay surface mount resistor and method for making same.

[0002] Surface mount resistors have been available for the electronics market for many years. Their construction has comprised a flat rectangular or cylindrically shaped ceramic substrate with a conductive metal plated to the ends of the ceramic to form the electrical termination points. A resistive metal is deposited on the ceramic substrate between the terminations, making electrical contact with each of the terminations to form an electrically continuous path for current flow from one termination to the other.

[0003] An improvement in surface mount resistors is shown in United States Patent 5,604,477. In this patent a surface mount resistor is formed by joining three strips of material together in edge relation. The upper and lower strips are formed from copper and the center strip is formed from an electrically resistive material. The resistive material is coated with a high temperature coating and the upper and lower strips are coated with tin or solder. The strips may be moved in a continuous path for cutting, calibrating, and separating to form a plurality of electrical resistors.

[0004] A primary object of the present invention is the provision of an improved overlay surface mount resistor and method for making same.

[0005] A further object of the present invention is the provision of an improved overlay surface mount resistor and method for making same which reduces the number of steps and improves the speed of production from that shown in U.S. Patent 5,604,477.

[0006] A further object of the present invention is the provision of an improved overlay surface mount resistor and method for making same wherein the resulting resistor is efficient in operation and improved in quality.

[0007] A further object of the present invention is the provision of an overlay surface mount resistor and method for making same which is economical to manufacture, durable in use and efficient in operation.

SUMMARY OF THE INVENTION

[0008] The foregoing objects may be achieved by a surface mount resistor comprising an elongated resistance piece of electrically resistive material having first and second end edges, opposite side edges, a front face and a rear face. The resistance piece of resistive material includes a plurality of slots formed in its side edges that create a serpentine current path between the first and second ends of the resistor.

[0009] First and second conductive pieces of conductive metal are each formed with a front face, a rear face, first and second opposite side edges, and first and second opposite end edges. The first and second conduc-

tive pieces each have their front faces in facing engagement and attached to the front face of the resistive material and are spaced apart from one another to create an exposed area of the front face of the resistive material there between. The first and second opposite edges of both the first and second conductive pieces are registered with or located between the first and second end edges and the opposite side edges of the elongated resistance piece.

[0010] The method of the present invention includes taking elongated resistive strip of electrically resistive material having first and second opposite ends, an upper edge, a lower edge, a front flat face, and a rear flat face. The method includes joining a first elongated conductive strip and a second elongated conductive strip of conductive material to the front flat face of the resistive strip in spaced relation to one another so as to create an exposed portion of the front flat face of the resistive strip between the first and second conductive strips. The joined strips are then sectioned into a plurality of separate body members. Next a plurality of slots are cut through the exposed portion of the resistive strip to create a serpentine current path in the resistive material of each of the body members. Next the resistive strips of each body member are encapsulated in a coating of electrically insulating material.

[0011] According to one feature of the invention, the attaching step comprises attaching an elongated wide conductive strip over substantially the entire surface of the front face of the resistive strip and then removing a central portion of the wide conductive strip to create the first and second elongated conductive strips and the exposed portion of the elongated resistive strip there between.

BRIEF DESCRIPTION OF THE FIGURES OF THE DRAWINGS

[0012]

Figure 1 is a perspective view of a resistor made according to the present invention.

Figure 2 is a schematic flow diagram showing the process for making the present resistor.

Figure 2A is an enlarged view taken along line 2A-2A of Figure 2.

Figure 3 is a sectional view taken along line 3-3 of Figure 2.

Figure 3A is a partial elevational view of the ribbon of Figure 3.

Figure 4 is an enlarged view taken along line 4-4 of Figure 2.

Figure 5 is an enlarged view taken along line 5-5 of Figure 2.

Figure 6 is an enlarged view taken along line 6-6 of Figure 2.

Figure 6A is a sectional view taken along line 6A-6A of Figure 6.

Figure 7 is an enlarged view taken along line 7-7 of Figure 2.

Figure 7A is a sectional view taken along line 7A-7A of Figure 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] Referring to Figure 1 the numeral 10 generally designates the surface mount resistor of the present invention.

[0014] Resistor 10 includes a central portion 12, first termination 14, and second termination 16. Terminations 14, 16 each include on their lower surfaces a first standoff 18 and a second standoff 20 respectively. Standoffs 18, 20 permit the resistor to be mounted on a surface with the central portion 12 spaced slightly above the surface of the circuit board.

[0015] Referring to Figures 2 and 2A, a reel 22 comprising a plurality of strips joined together into one continuous ribbon designated by the numeral 21. Ribbon 21 comprises a carrier strip 24 which is welded to an overlay strip 26 along a weld line 36. Overlay strip 26 comprises a resistive strip 28 having first and second conductive strips 30, 32 attached to one surface thereof.

[0016] The method for manufacturing the continuous ribbon 21 is as follows: Beginning with a strip of metallic resistance material 28 of the proper width and thickness and a single strip of copper of the same width, the two metals are joined together through a metal cladding process to form overlay strip 26. The cladding process is a process well known in the art for joining dissimilar metals through the application of extremely high pressure without braising alloys or adhesives. The resulting overlay strip 26 is of double thickness, one thickness being the copper strip and one thickness being the resistive strip.

[0017] The next step in the process involves removing a center portion of the conductive strip so as to create the upper conductive strip 30 and the lower conductive strip 32 with an exposed portion 34 therebetween. The removal may be accomplished by grinding, milling, skiving (shaving) or any other technique well known in the art for removing metal. Once removed, the exposed portion 34 electrically separates the upper conductive strip 30 and the lower conductive strip 32. This can be readily seen in Figures 3 and 3A. In Figure 2A the block 38 represents the attaching of the carrier strip 24 to the overlay strip 26 by welding, and the block 40 represents the removal of the center of the conductive strip to create the upper and lower conductive strips 30, 32.

[0018] Next in the manufacturing process is the punching step represented by block 42 in Figure 2. In this punching step holes 44 are punched in the carrier ribbon to permit the ribbon to be indexed throughout the remainder of the manufacturing process.

[0019] Next the block 46 represents the separating step for separating each of the various electrical resis-

tors into separate bodies. This step is shown in detail in Figure 4. The upper portion of overlay strip 26 is trimmed to create the upper edges 48 of each of the body members. Then a vertical separating slot 50 is cut or stamped between each of the bodies 51.

[0020] A cut line is represented by the dotted line 37, and represents where a cut will be performed later in the process. Slots 50 extend below cut line 37.

[0021] The separated resistor bodies are next moved to an adjustment and calibration station 52. At this station each body is adjusted to the desired resistance value. Resistance value adjustment is accomplished by cutting alternative slots 54, 56 (Figure 5) through the exposed portion 34 of the resistance material of resistance strip 28. This forms a serpentine current path designated by the arrow 58. The serpentine path increases the resistance value of the resistor. The slots are cut through the resistance material using preferably a laser beam or any instrument used for the cutting of metallic materials. The resistance value of each resistor is continuously monitored during the adjustment cutting until the desired resistance is achieved.

[0022] After the resistors are adjusted to their proper resistance value the bodies are moved to an encapsulation station 60 where a dielectric encapsulating material 62 is applied to the exposed front and rear surfaces and edges of the resistive strip 28. The purposes of the encapsulating operation are to provide protection from various environments to which the resistor may be exposed; to add rigidity to the resistance element which has been weakened by the value adjustment operation; and to provide a dielectric insulation to insulate the resistor from other components or metallic surfaces it may contact during its actual operation. The encapsulating material 62 is applied in any manner which covers only the resistive element materials 28. A liquid high temperature coating material roll coated to both sides of the resistor body is the preferred method. The conductive elements 30, 32 of each body are left exposed. These conductive strips 30, 32 of the resistor serve as electrical contact points for the resistor when it is fastened to the printed circuit board by the end user. Since the ends 30, 32 on the resistor are thicker than the resistive element 28 in the center of the resistor, the necessary clearance is provided for the encapsulation on the bottom side of the resistor as shown in Figure 6A.

[0023] Next in the manufacturing process is the application of marking information, printing, to the encapsulated front surface of the resistor. This step is represented by block 64 in Figure 2. This is accomplished by transfer printing the necessary information on the front surface of the resistor with marking ink. The strip is then moved to the separating station represented by block 70 where the individual resistors are cut away from the carrier strip 24. The individual resistors are plated with solder to create a solder coating 68 as shown in Figure 7A. The individual resistors 10 are then complete and they are attached to a plastic tape 74 at a packaging

station represented by the numeral 72.

[0024] The above process can be accomplished in one continuous operation as illustrated in Figure 2 or it is possible to do the various operations one at a time on the complete strip. For example, the attachment and removing steps can be accomplished either before or after the continuous ribbon 21 is wound on a spool. The punching of the transfer holes 44, the trimming and the separation can then be accomplished by unwinding the spool and moving the strip through stations 46, 52, 60 to accomplish these operations. Similar operations can be accomplished one at a time by unwinding the spool for each operation.

[0025] For the welding of weld joint 36 the preferred method of welding is by electron beam welding. However, other types of welding or attachment may be used. The preferred method for forming the transfer holes, for trimming the upper edge of the strip to length, and forming the separate resistor blanks is punching. However, other methods such as cutting with lasers, drilling, etching, or grinding may be used.

[0026] The preferred method for calibrating the resistor is to cut the resistor with a laser. However, punching, milling, grinding or other conventional means may be used.

[0027] The dielectric material used for the resistor is preferably a rolled high temperature coating, but various types of paint, silicon, and glass in the forms of liquid, powder or paste may be used. They may be applied by molding, spraying, brushing or static dispensing.

[0028] The marking ink used for the resistor is preferably a white liquid, but various colors and types of marking ink may be used. They may be applied by transfer pad, ink jet, transfer roller. The marking may also be accomplished by use of a marking laser beam.

[0029] The solder used in the present invention may be a plating which is preferable, or a conventional solder paste or hot tin dip may be used.

Claims

1. A method for making a plurality of surface mount resistors comprising:

taking a ribbon comprising a elongated resistive strip (28), an elongated first metallic strip (32) and an elongated second metallic strip (30), the resistive strip having a longitudinal axis, an upper edge, a lower edge, a front flat surface, a rear flat surface and a central portion (12) between the upper and lower edges, the resistive strip being made of a resistive material and the first and second metallic strips being made of a metallic material that is different from the resistive material;

joining the elongated first and second metallic strips to the front flat surface of the resistive

strip adjacent the upper and lower edges thereof respectively, with the first and second metallic strips being spaced apart from one another across the central portion (12) of the resistive strip, the joining being done by a cladding process without the use of braising alloys or adhesive;

making a plurality of cuts (50) in a direction transverse to the longitudinal axis of the resistive strip so that the plurality of cuts extend through the resistive strip and the first and second strips to create a plurality of resistor bodies (51), each of the resistor bodies comprising a resistance member having front and back surfaces, first and second conductive metal terminal ends attached to the front surface of the resistance member and spaced apart from one another, and an exposed portion of the front surface of the resistance member between first and second terminal ends;

connecting the plurality of resistor bodies together while making the plurality of cuts so as to hold the plurality of resistor bodies together; and

severing the resistor bodies from one another to create the plurality of surface mount resistors.

2. The method of claim 1 wherein the step of joining the first and second strips to the resistance element further comprises attaching a single conductive strip in superimposed relation over the front surface of the resistive strip and removing a central portion of the single conductive strip to create the first and second conductive strips spaced apart from one another across the central portion of the resistive strip.
3. The method of claim 1 and further comprising using copper for the metal of the first and second strips.
4. An electrical surface mount resistor comprising:

a resistance element (28) made of electrical resistive material and having a front surface comprising a first end portion, a second end portion, and a central portion (12) between the first and second end portions, the resistance element also having a back surface;

first and second terminals (30, 32) both made of a metal that is different from the resistive material of the resistance element, the first and second terminals covering the first and second end portions of the front surface of the resistance element in a position not electrically connected to one another and being spaced apart from one another across the central portion of the front surface of the resistance element; the first and second terminals being joined by

cladding without any adhesives or braising alloys to the first and second end portions of the front surface of the resistance element;
a dielectric material (62) in covering relation over the front and back surfaces of the resistance element. 5

5. The resistor of claim 4 wherein the metal of the first and second terminals is copper.

10

15

20

25

30

35

40

45

50

55

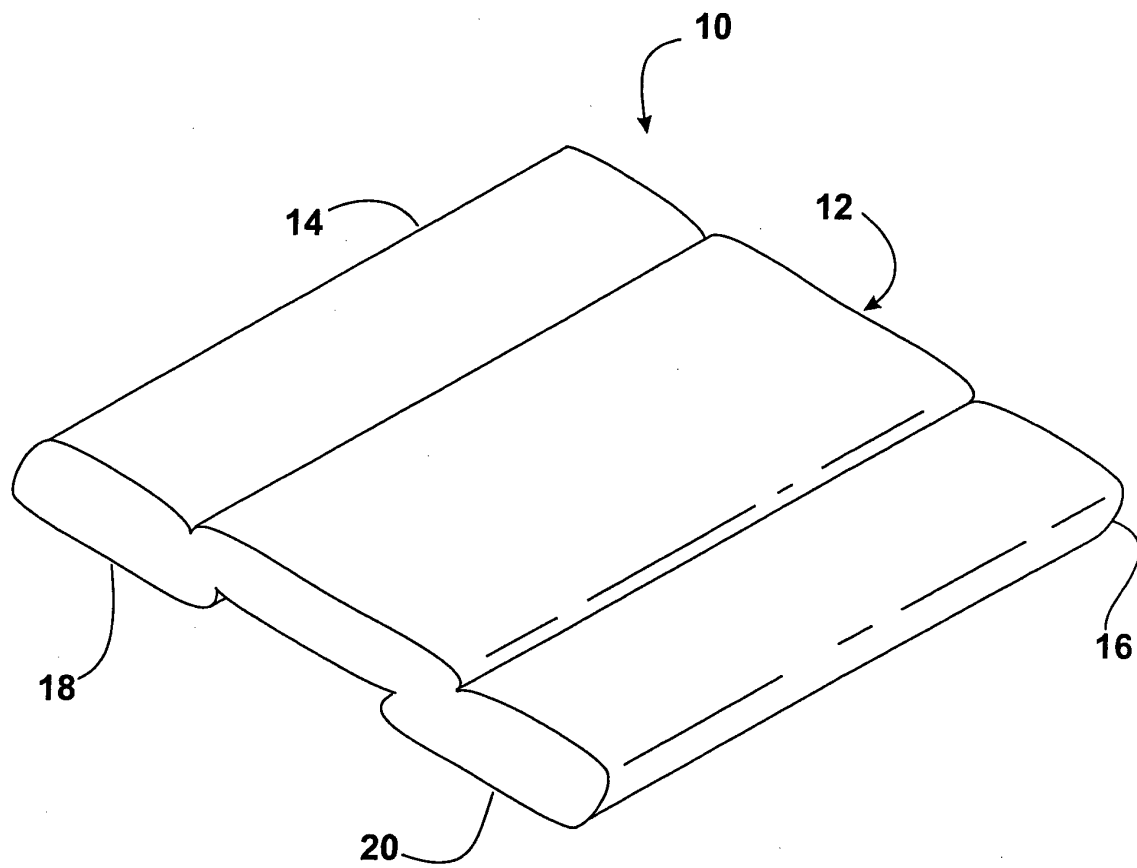


Fig. 1

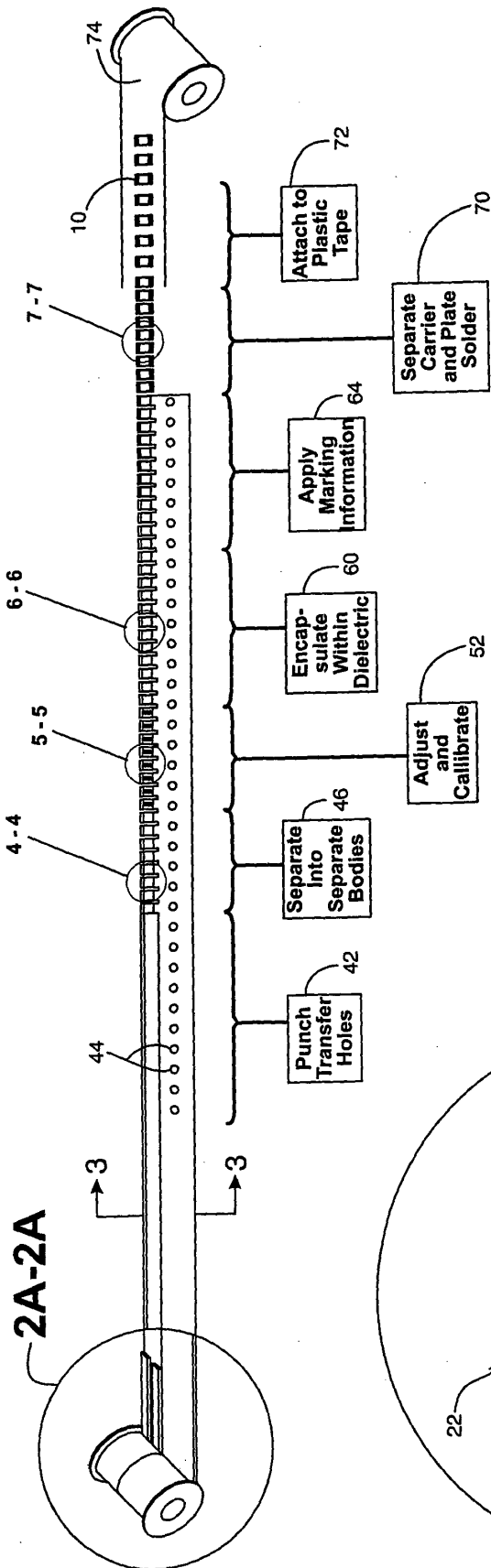


Fig. 2

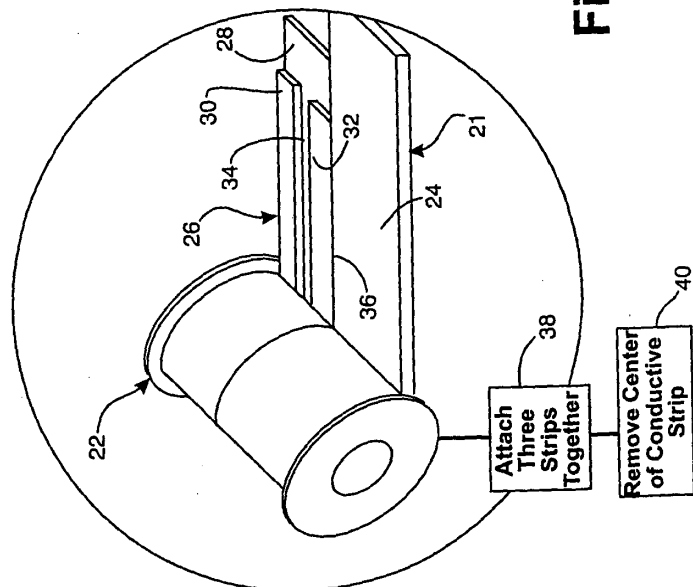


Fig. 2A

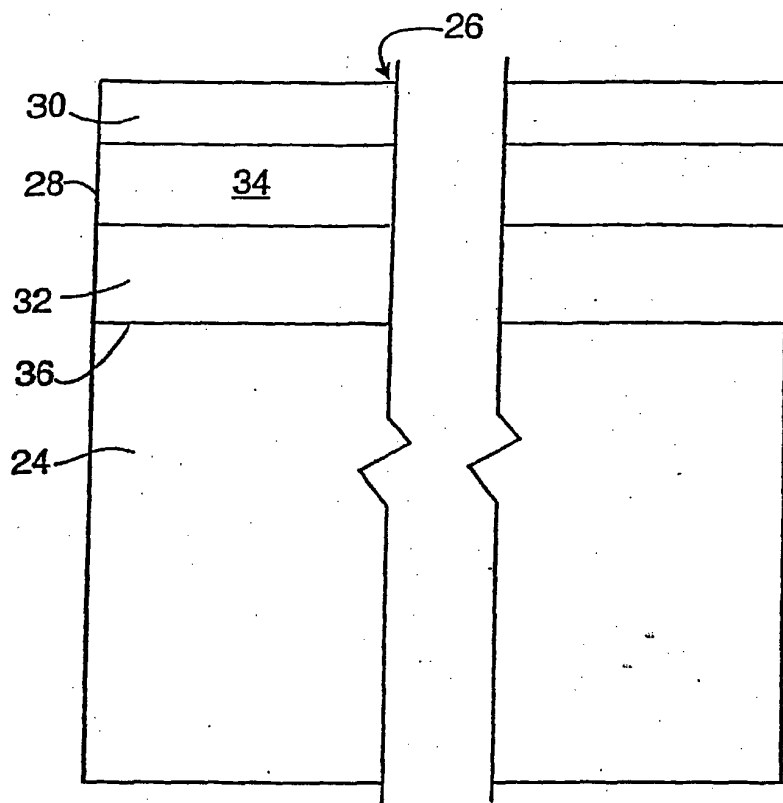


Fig. 3A

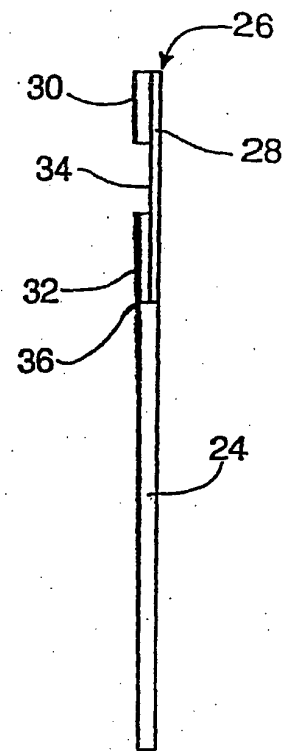


Fig. 3

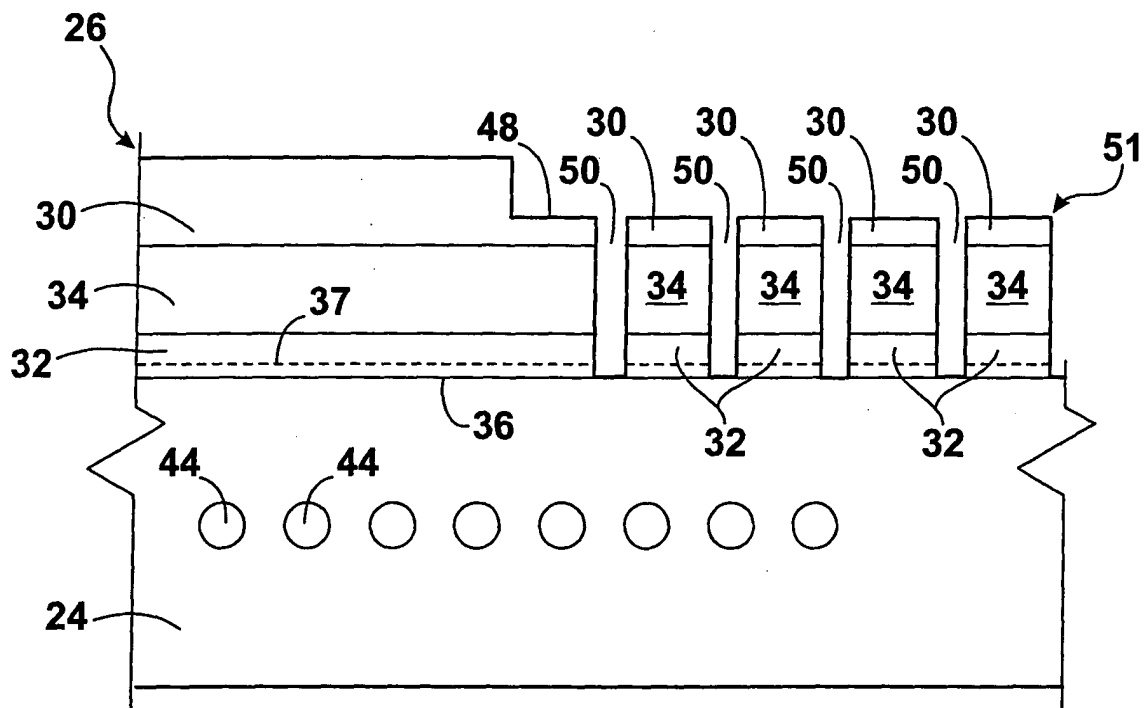


Fig. 4

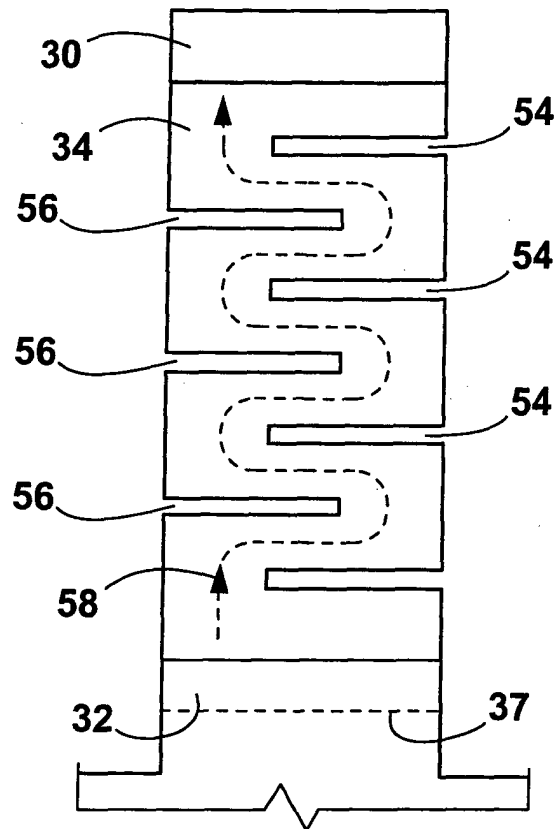


Fig. 5

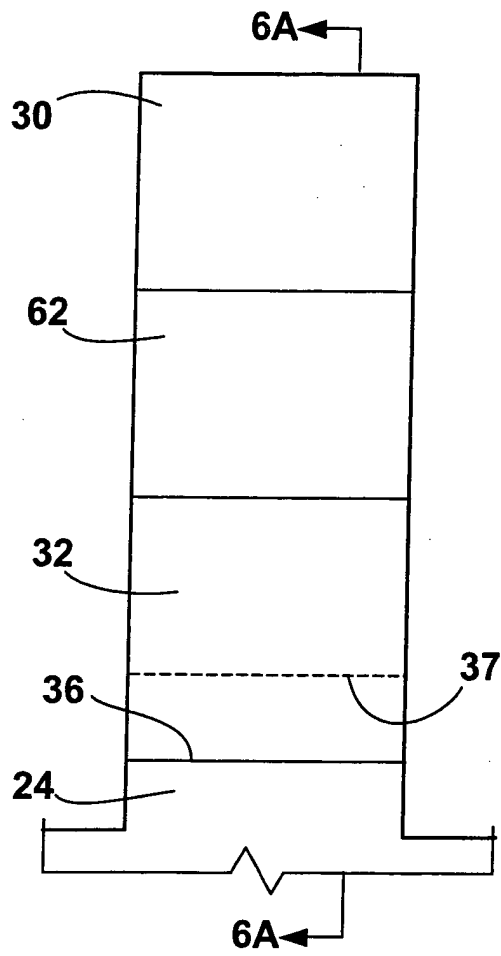


Fig. 6

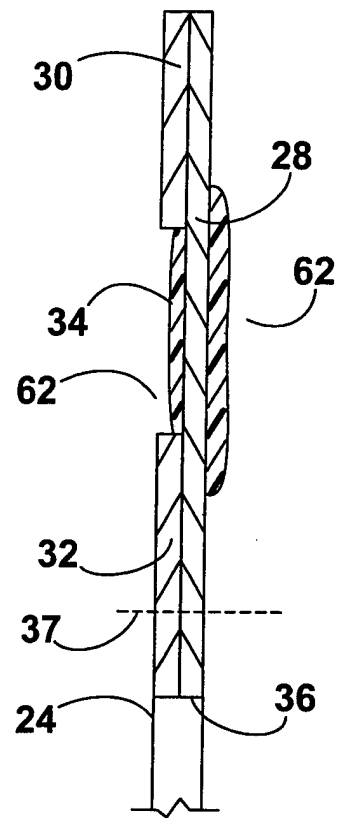


Fig. 6A

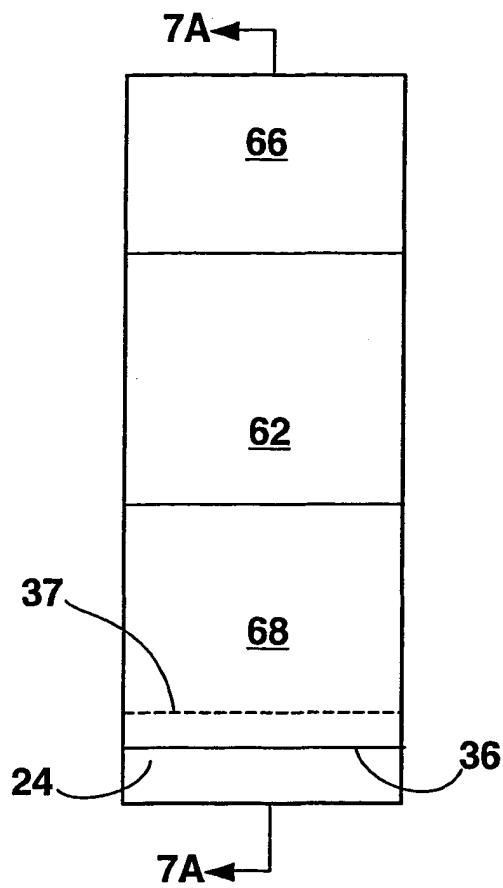


Fig. 7

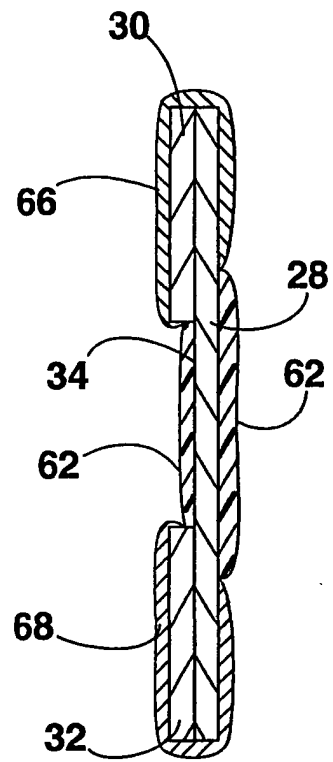


Fig. 7A



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 07 8539

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,A	US 5 604 477 A (RAINER WALTER ET AL) 18 February 1997 (1997-02-18) Entire document	1-6	H01C17/00
A	DE 30 40 930 A (SIEMENS AG) 13 May 1982 (1982-05-13) * claims 1,4,9 * * page 8, line 32 - page 9, line 4 *	1-6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H01C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 February 2005	Examiner Lescop, E
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 07 8539

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

15-02-2005

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5604477	A	18-02-1997	AT 176830 T	15-03-1999
			CA 2164017 A1	08-06-1996
			DE 69507871 D1	25-03-1999
			DE 69507871 T2	07-10-1999
			EP 0716427 A2	12-06-1996
			JP 3321724 B2	09-09-2002
			JP 8236324 A	13-09-1996

DE 3040930	A	13-05-1982	DE 3040930 A1	13-05-1982
